NUTRIENT POLLUTION IN THE SIPPICAN RIVER?

A Report of Three Years of GLOBE Data

Sippican River

By: Tabor Academy Advanced Environmental Science Class

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INTRODUCTION

Tabor Academy under the direction of Mr. Richard Harlow, became a GLOBE school on November 26, 1996. GLOBE is an acronym for Global Learning and Observation to Benefit the Environment. Since that date hydrology measurements of Sippican River have been taken every weekend for three years. Tabor Academy has tested the following hydrology parameters: water temperature, dissolved oxygen, pH, alkalinity, turbidity, conductivity, total nitrogen, nitrate plus nitrite and total phosphate in the Sippican River Watershed. These measurements as well as daily measurements of atmosphere, soil moisture and soil temperature taken at the school, are sent to the G.L.O.B.E. data input website in Denver, Colorado.

The collected data became important when depletion in the herring population was discovered. Although there were no statistical references comparing the population from the past to the present, a herring inspector, when asked, said there "were obviously more herring in the past." Thus Mr. Harlow's Environmental Science class became concerned that this may be the result of nutrient pollution in the watershed. Our tests have shown that the oxygen levels have gone down to as low as 4 mg per liter two out of the three years and have been a marginal 5-mg per liter for five weekends during the summer. These measurements are not expected in a free flowing river. Low oxygen levels, high nitrate and phosphate and abnormal pH levels can affect the normal nutrient level of the river. Our three test sites include:

* Hathaway Pond, a very shallow and eutrophic pond, the result of a dam in Sippican River,
* Doggett Brook, which enters Sippican River roughly 1000 yards below the dam,
* Sippican River at the County Road bridge which is at the upper end of the Sippican River estuary.

Our goal is to look at the collected data and determine whether or not the information proves there should be a concern. Nutrient pollution in the Sippican River would flow into the Weeweeantic River estuary, which is a direct link to Buzzards Bay. If nutrient pollution is seeping into the Bay, it could change the chemical identity of Sippican River thus becoming a detriment for herring and other anadromous fish, as well as being potentially harmful to saltwater organisms.

APPARATUS AND PROCEDURE

The tests for water temperature, dissolved oxygen, pH, total dissolved solids (conductivity), alkalinity, nitrogen, phosphate and turbidity (water transparency) were taken on a weekly basis. The testing process was conducted on site using the back of Mr. Harlow's Explorer as our laboratory every Sunday. On Saturday or Sunday morning before leaving the Schaefer Laboratory each kit was calibrated to a known standard.

Each test has a different procedure that will be summarized in this section.

Water Sample

A bucket is used to retrieve a sample of water. The bucket is first rinsed with the water from the sample area. It is then immersed to quickly remove a sample with minimum disturbance of the water. The sample is brought back to the vehicle and stored on the shaded side of the vehicle. This prevents changes in water characteristics while it is being tested.

Water Temperature

The Water Temperature test is conducted with a centigrade thermometer. First, holding the end opposite the bulb and shaking it repeatedly clears the thermometer. The thermometer is then placed approximately 10 cm deep for approximately a 3-minute duration. Then, the thermometer is raised slightly from the water in order to read the temperature without taking it completely out of the water. The thermometer is lowered again for one minute and the temperature is taken a second time to compare the two results. If the temperatures vary, the average of the two is taken and recorded.

Dissolved Oxygen

The dissolved oxygen test is conducted from a HACH Chemical Company DO Test Kit. This kit includes the use of one round bottle with stopper, Oxygen one and two powder chemicals, an acid and Sodium Thiosulfate solution, one small square bottle, a dropper and a small aliquot test tube.
First, the round sample bottle is carefully immersed in the bucket so that no bubbles are created. While on the bottom of the bucket the stopper is inserted and the bottle is removed from the bucket. Now Oxygen one and two are added to the sample bottle, stopper in place and the bottle is vigorously shaken to mix the chemicals. A floc will be observed throughout the liquid. When the floc has settled a third of the way to the bottom of the sample, the bottle is shaken again. When the floc settles to the bottom, or at least two thirds to the bottom of the sample bottle the acid reagent is added. This will impart a rich yellow to yellow-orange color to the liquid. The sample bottle is vigorously shaken again and set

aside for 1 minute. A small aliquot tube is filled with the resulting sample and placed into the square bottle. Drops of Sodium Thiosulfate are then added to the sample until the color of the liquid is clear. The amount of drops of Sodium Thiosulfate it takes to clarify the liquid is equal to the number of milligrams of dissolved oxygen per liter in the water sample.

pH

The amount of Hydrogen ions in solution is considered the pH of that solution. We use an Oakton waterproof pH Meter that is calibrated just before we go into the field. The calibration is standardized with three known pH solutions, pH 4, pH 7 and pH 10. A 100-ml sample is taken from the bucket. The pH meter is first rinsed with distilled water before it is inserted into the sample. The meter is turned on and the resulting reading is recorded.

Total Dissolved Solids (Conductivity)

The Oakton TDS meter measures the amount of total dissolved solids in water. It also is calibrated before we leave for the field with a 447.1μS solution. Another, but different 100 ml sample is taken from the bucket. The conductivity meter is rinsed with distilled water before it is inserted into the sample. The meter is turned on and the reading is recorded.

Alkalinity

With this test, a HACH Chemical Company Alkalinity Test Kit is used. This kit includes a glass bottle marked at 15 ml., an eyedropper, one Bromcresol Green-Methyl red indicator packet and Sulfuric Acid solution. The glass bottle is filled to the 15-ml line from the sample bucket. One powder packet of Bromcresol Green-Methyl Red is added to the sample and the sample is stirred. Usually a blue-gray or gray- green color develops. Then one drop at a time is added until the solution turns a rose pink. Alkalinity is measured in grams per gallon of Calcium Carbonate ($CaCO_3$).

HACH Colorimeter

For Nitrogen (Nitrate and Nitrite) and Phosphate a Hach DR/890 Colorimeter is used. For each test the specific program for the specific test is entered using the program key and entering the specific code for the test to be conducted.

Nitrate and Nitrite

Three glass tubes are filled to the 10-ml mark with the sample from the bucket. One tube is labeled Blank, the other tubes are labeled Nitrate and Nitrite. Each tube has a HACH chemical, (e.g. NitraVer 5 powder pillow for Nitrate), that is opened and added to each tube. Each tube is mixed (shaken) for a specified period of time and then allowed to rest for a specified time, (e.g. 5 minutes for Nitrate, 15 minutes for Nitrite). After the specified rest period and at the specific frequency for each test three measurements are taken and an average is determined for each test. Even if 0.0 is observed on the meter, three checks are made to be sure.

Phosphorous

Two glass tubes are filled to the 10-ml mark with the sample from the bucket. One tube is labeled Blank, the other tube is labeled Phosphate. PhosphVer 3 powder pillow is added to the Phosphate tube and vigorously shaken for 15 seconds. A rest of 2 minutes is required for this test. After two minutes if phosphate is present there will be a slight bluish color to the solution. The stronger the blue represents an increase in phosphate in the sample. If this happens (as it has on several occasions) a serial dilution is made and tested.

Turbidity (Water Transparency)

To test the water's transparency at our test sites we use a turbidity tube that is 117 cm long with a small homemade Secchi disk to fit the bottom of the tube. The Secchi disk is a circle divided into quarters, each quarter alternating between black and white. When the tube is filled with the sample water, at the point when the Secchi disk is no longer visible, that point is measured and recorded. If the disk is visible with the tube completely filled than the water is considered clear above 117 cm.

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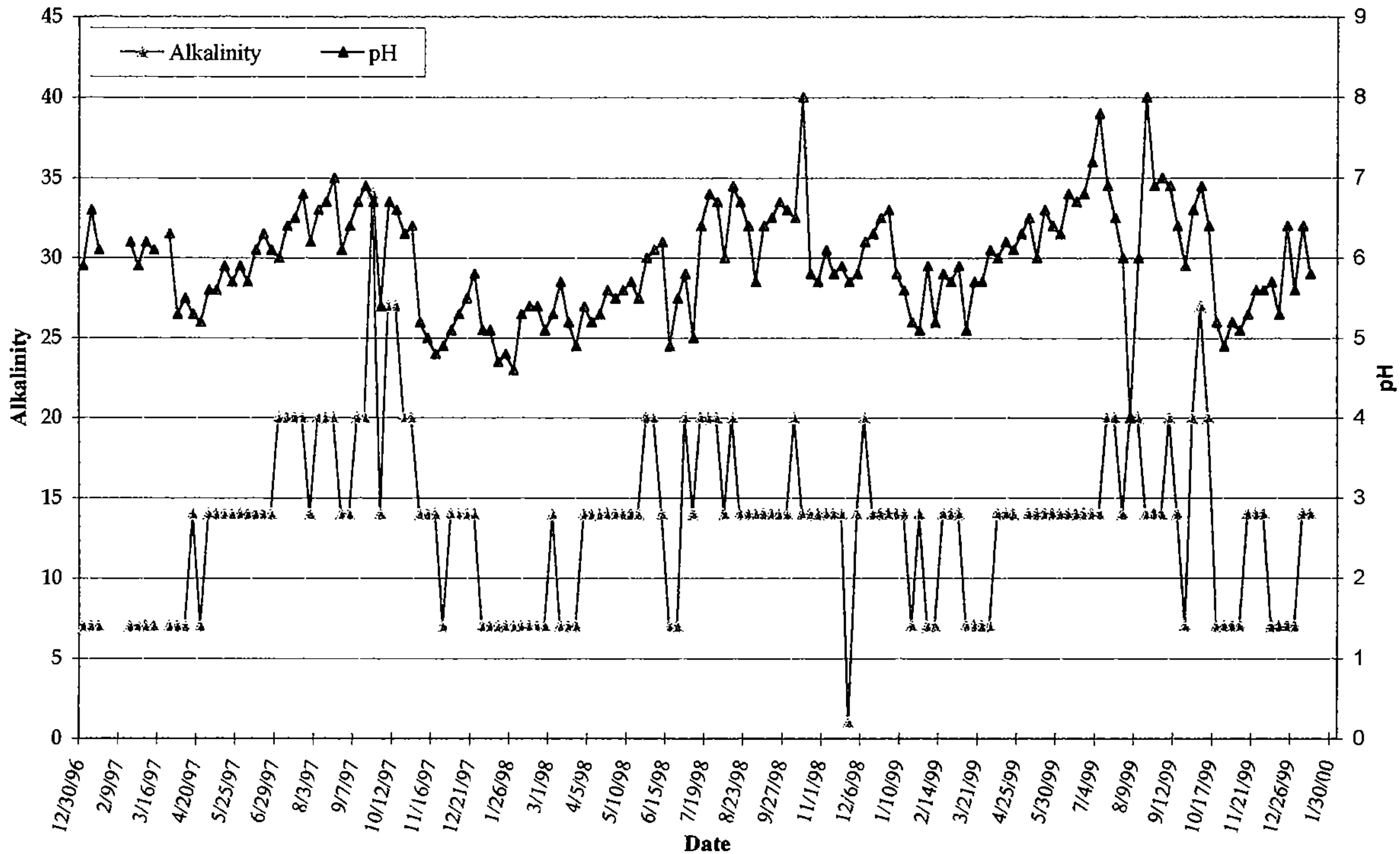
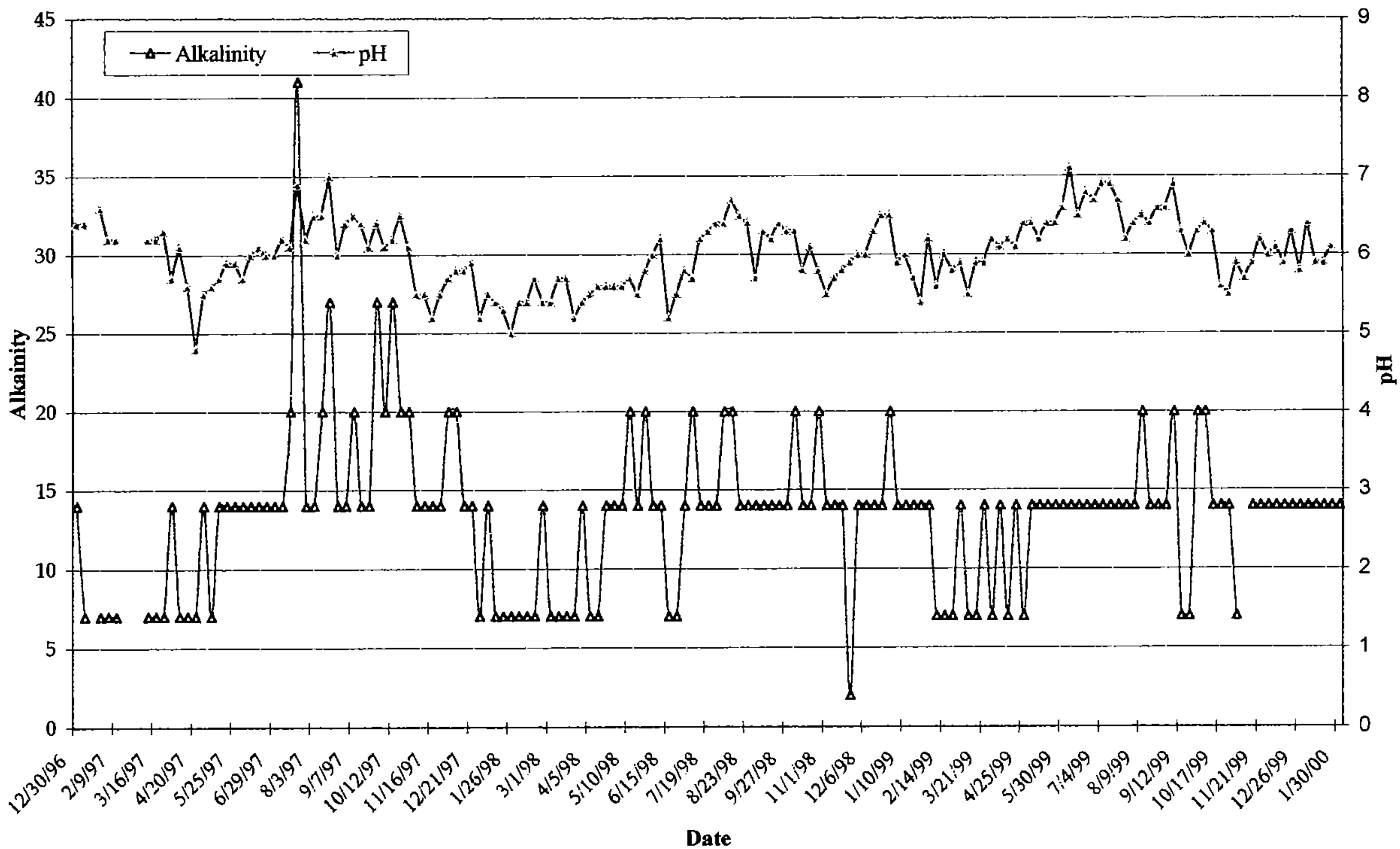
HACH Chemical Company DR/890

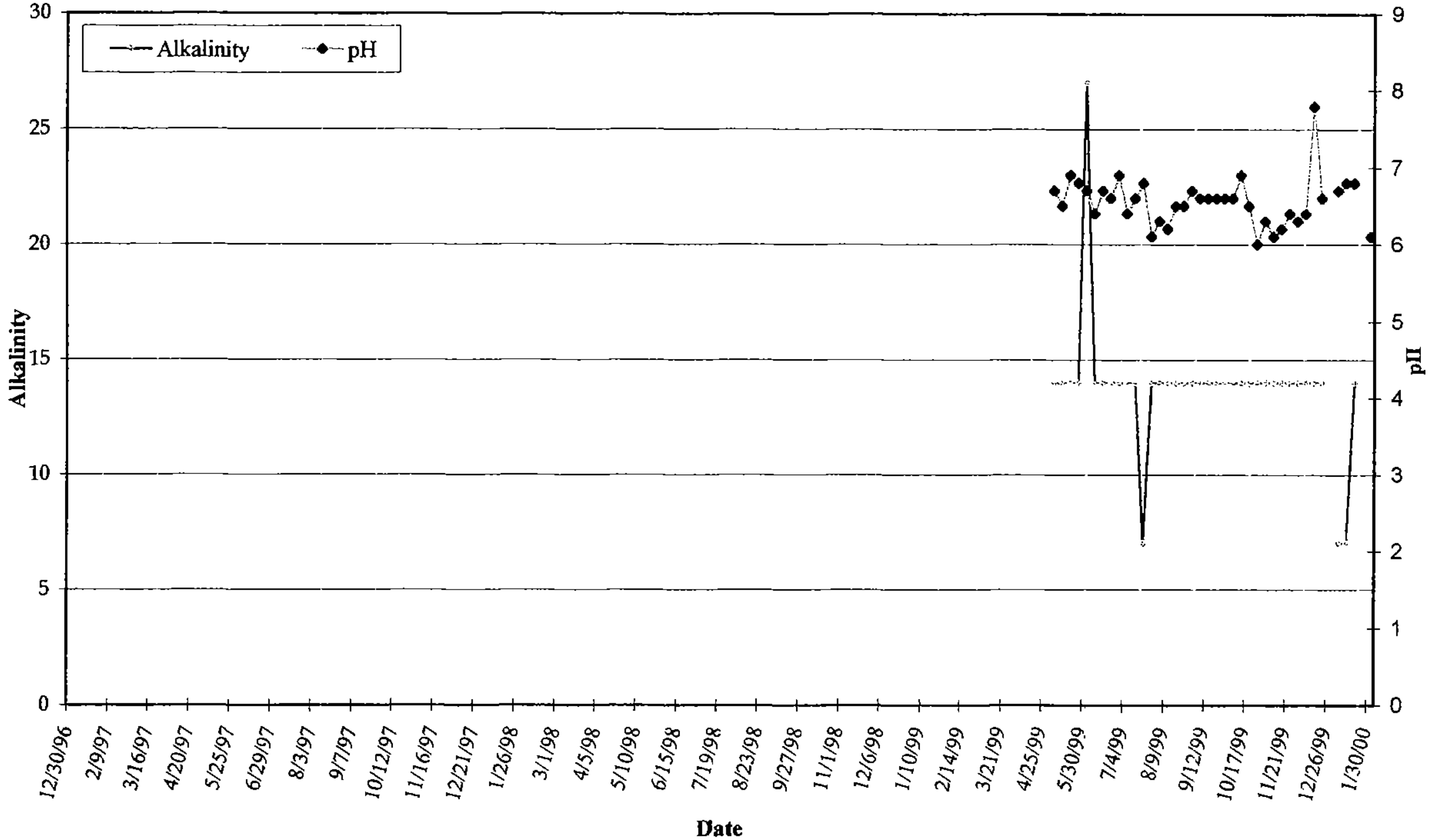
A. Alkalinity vs. pH at Dogget Brook



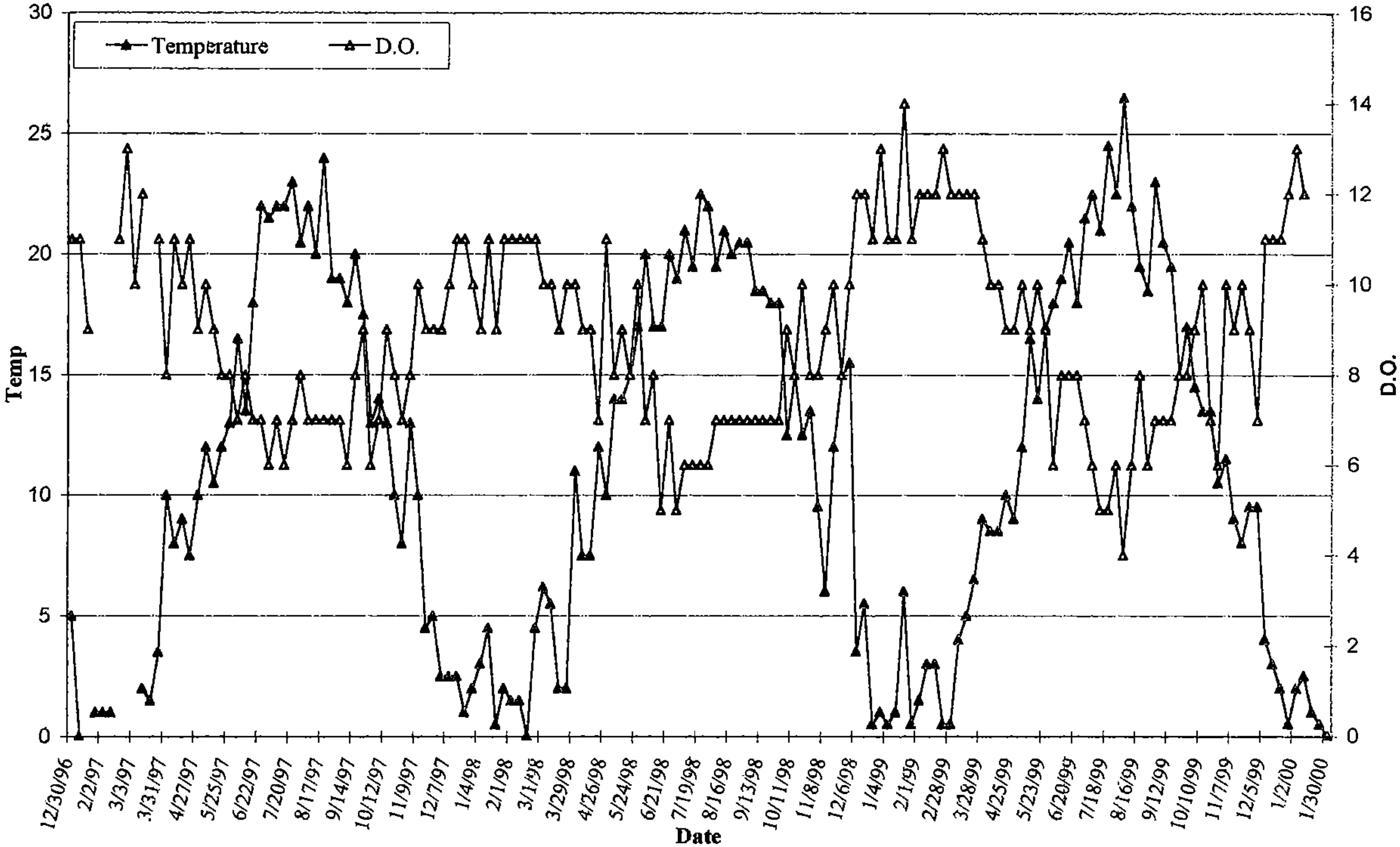
B. Alkalinity vs. pH at Sippican River



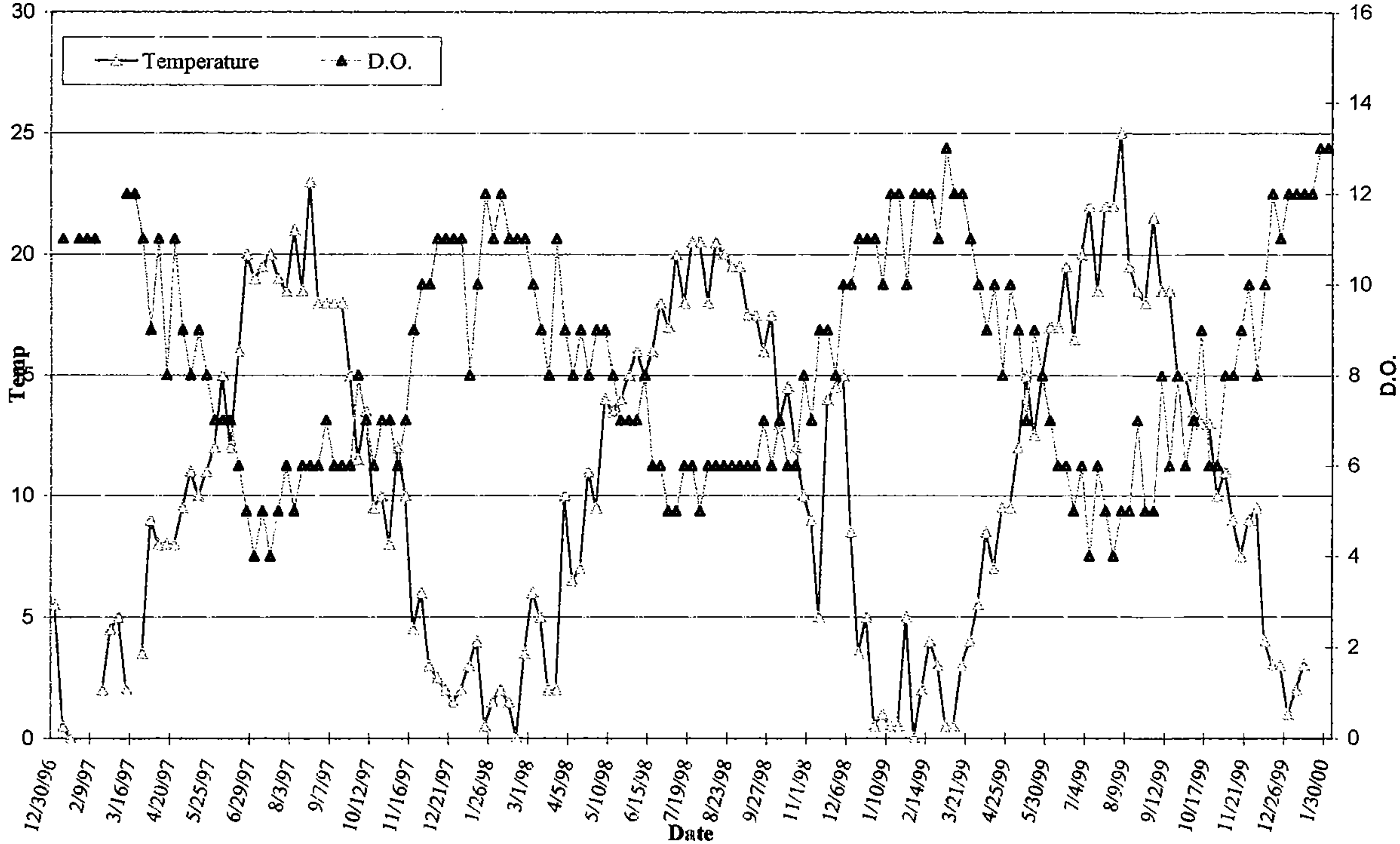
C. Alkalinity vs. pH at Hathaway Pond



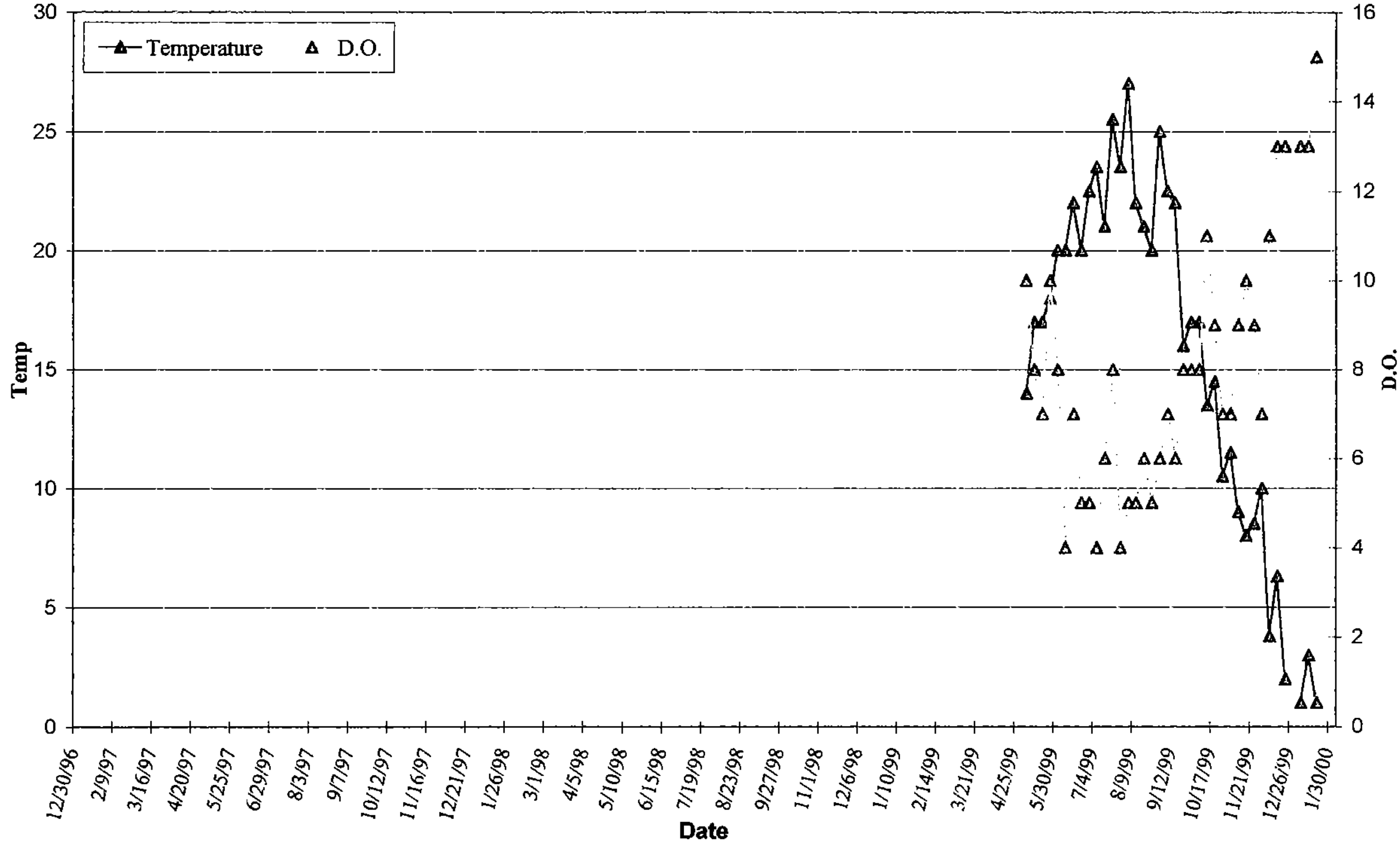
D. Temperature vs. Dissolved Oxygen at Dogget Brook



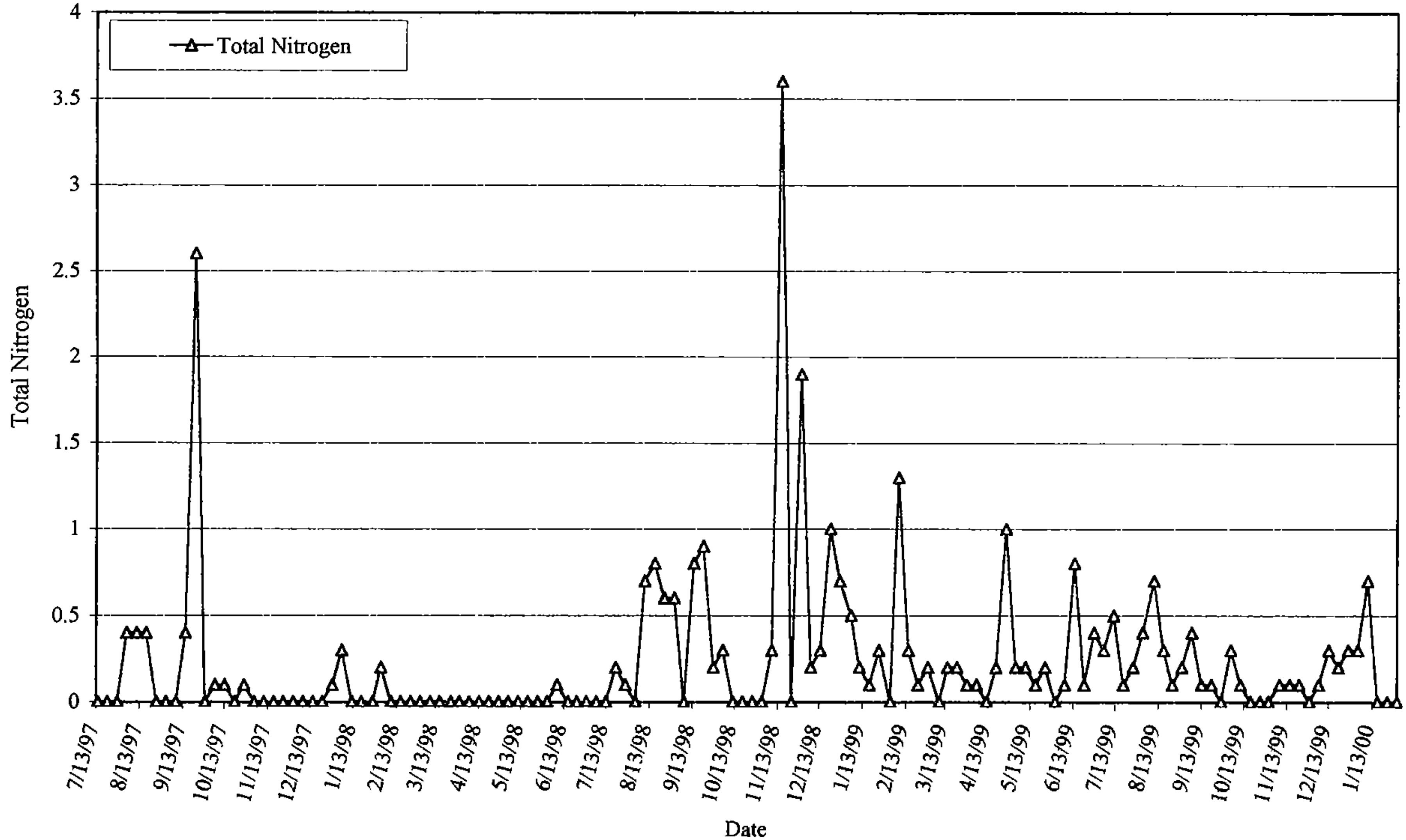
E. Temperature vs. Dissolved Oxygen at Sippican River



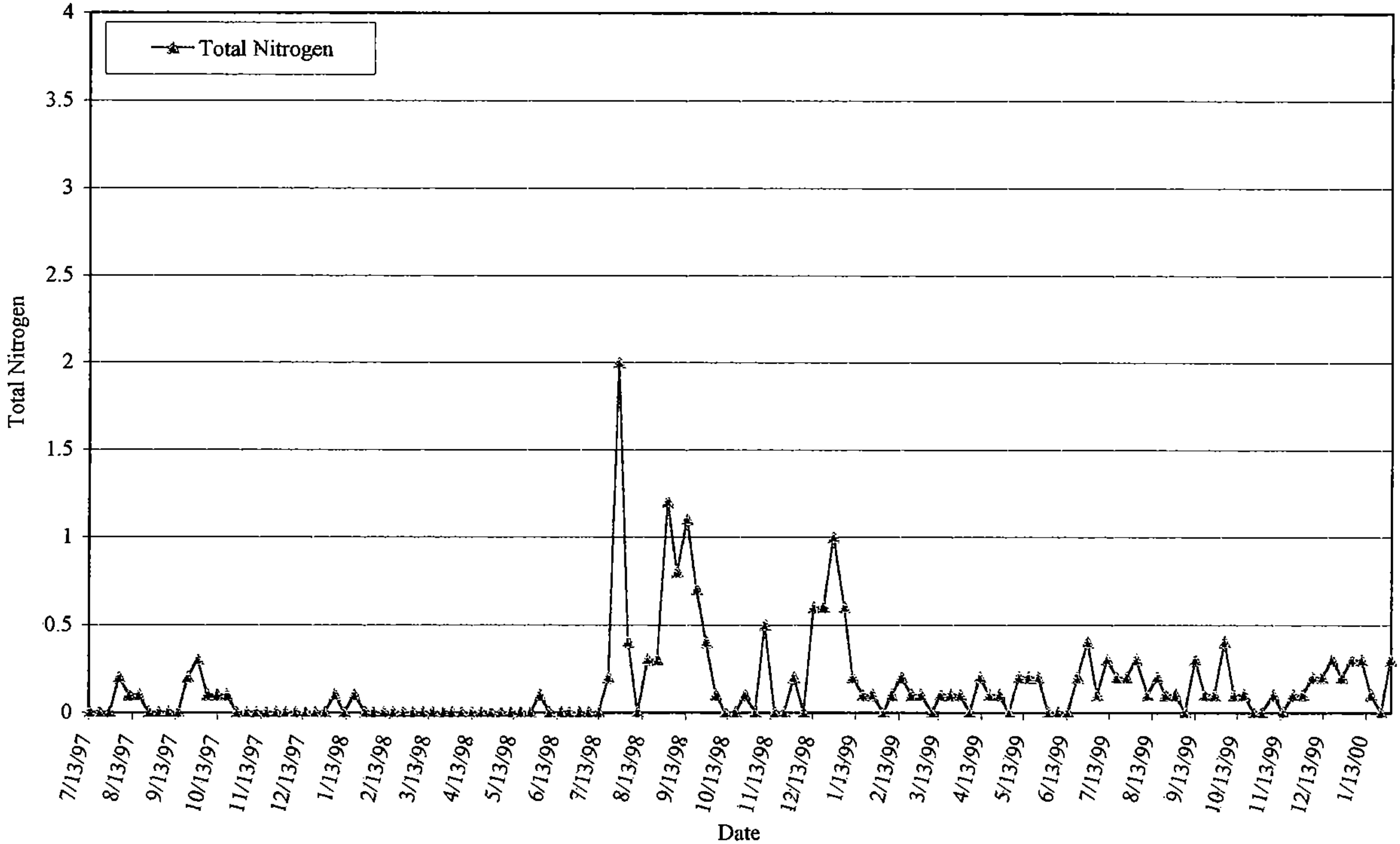
F. Temperature vs. Dissolved Oxygen at Hathaway pond



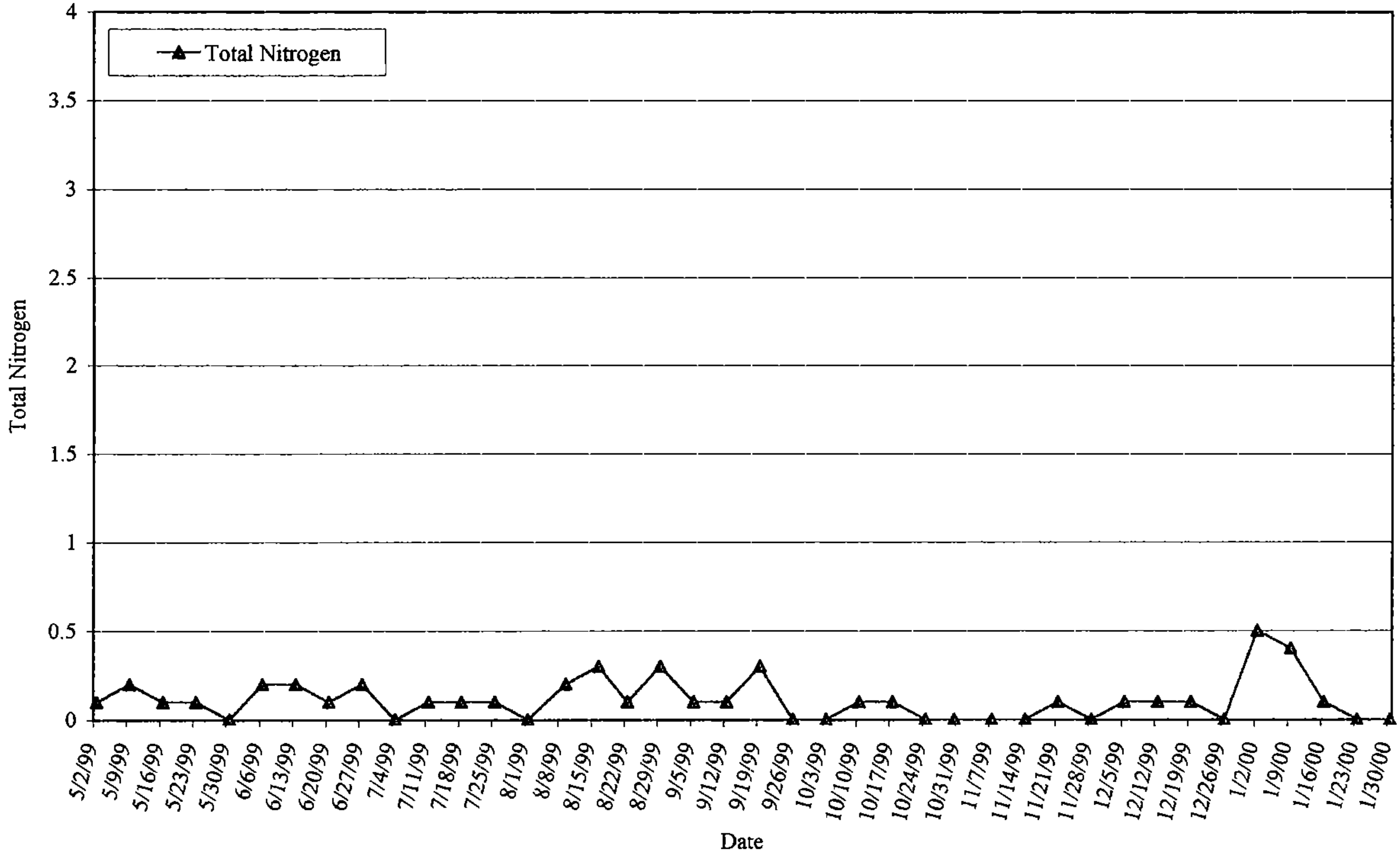
G. Total Nirogen (Nitrate and Nitrite) at Doggett Brook



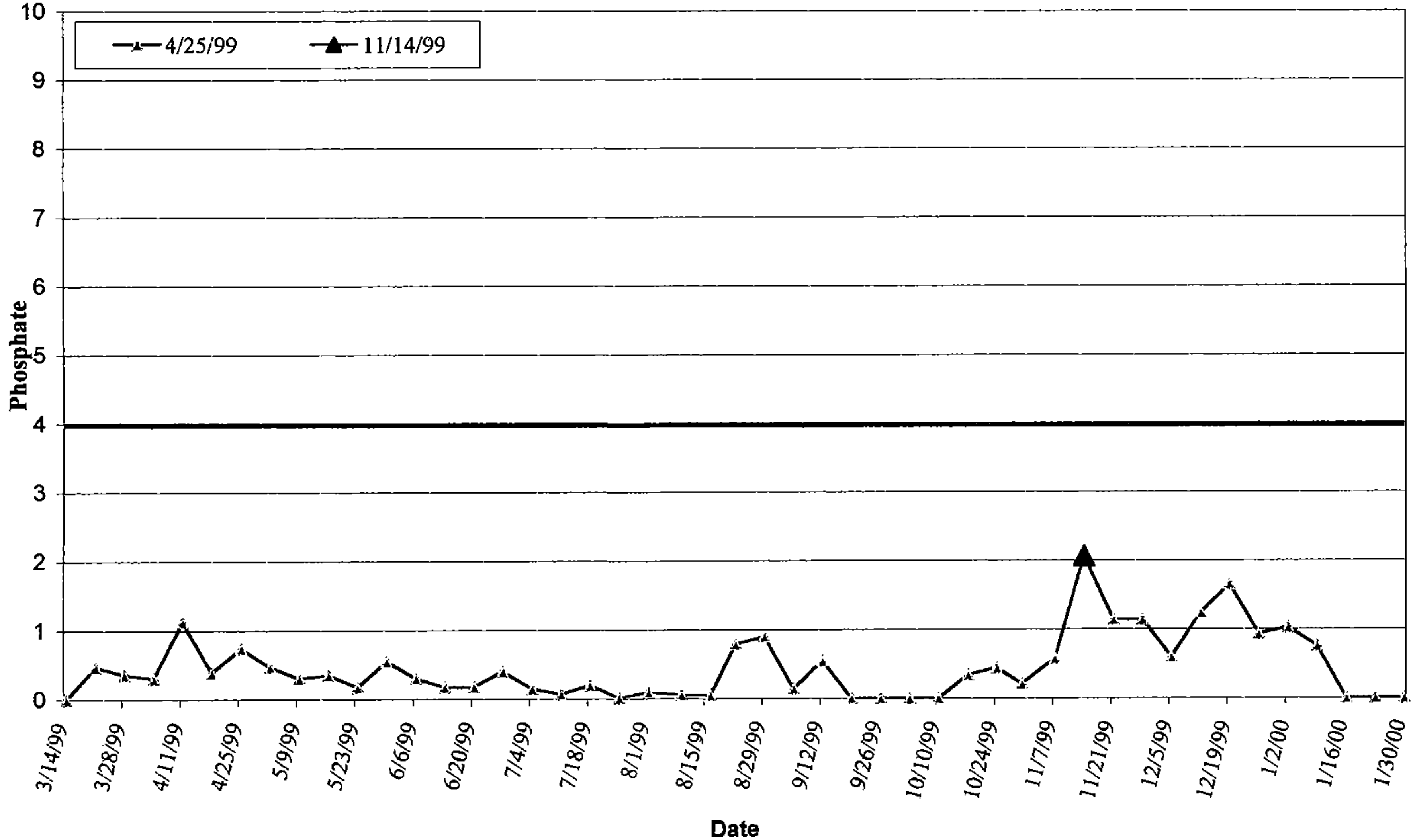
H. Total Nitrogen(Nitrate and Nitrite) at Sippican River



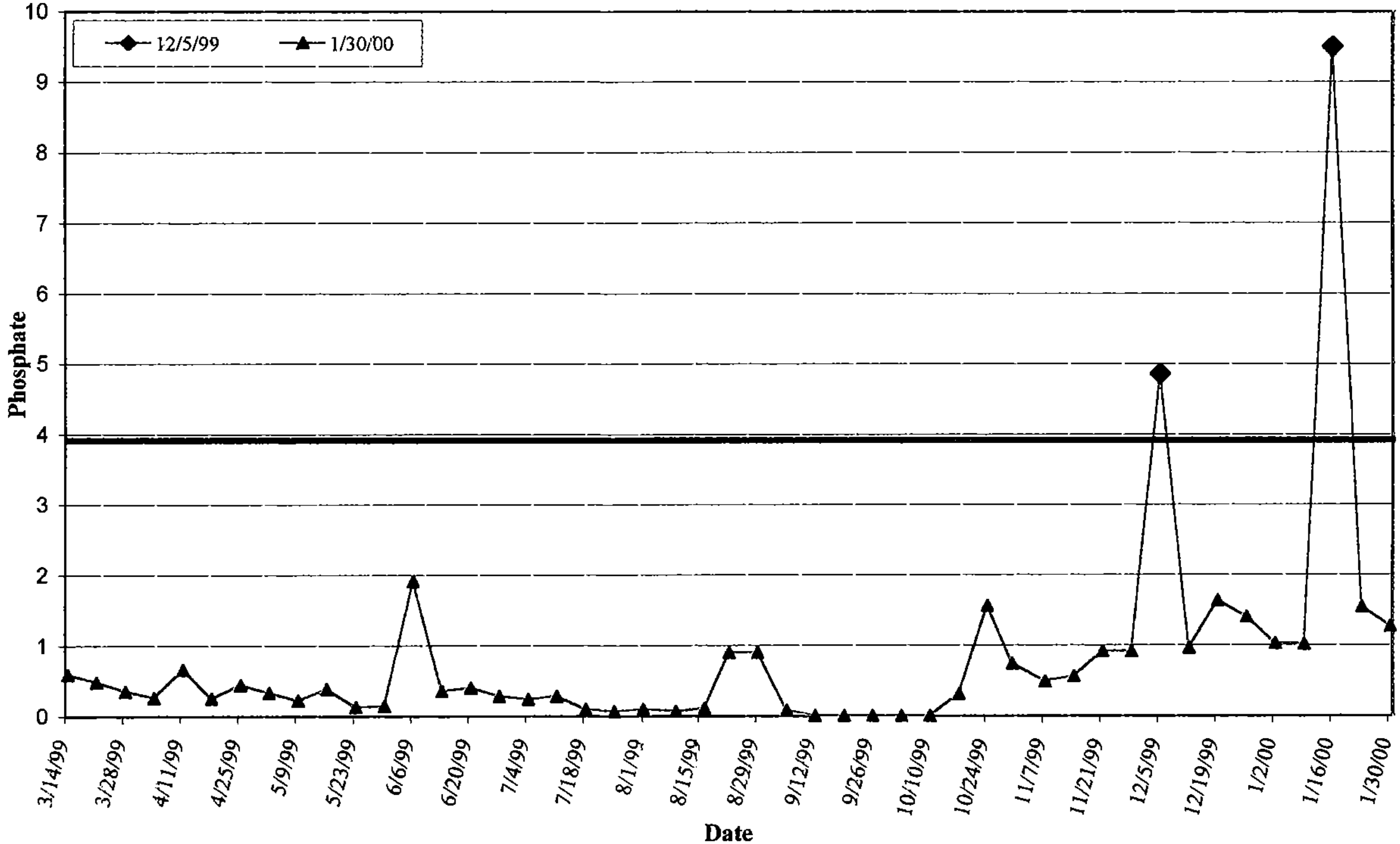
I. Total Nitrogen(Nitrate and Nitrite) at Hathaway Pond



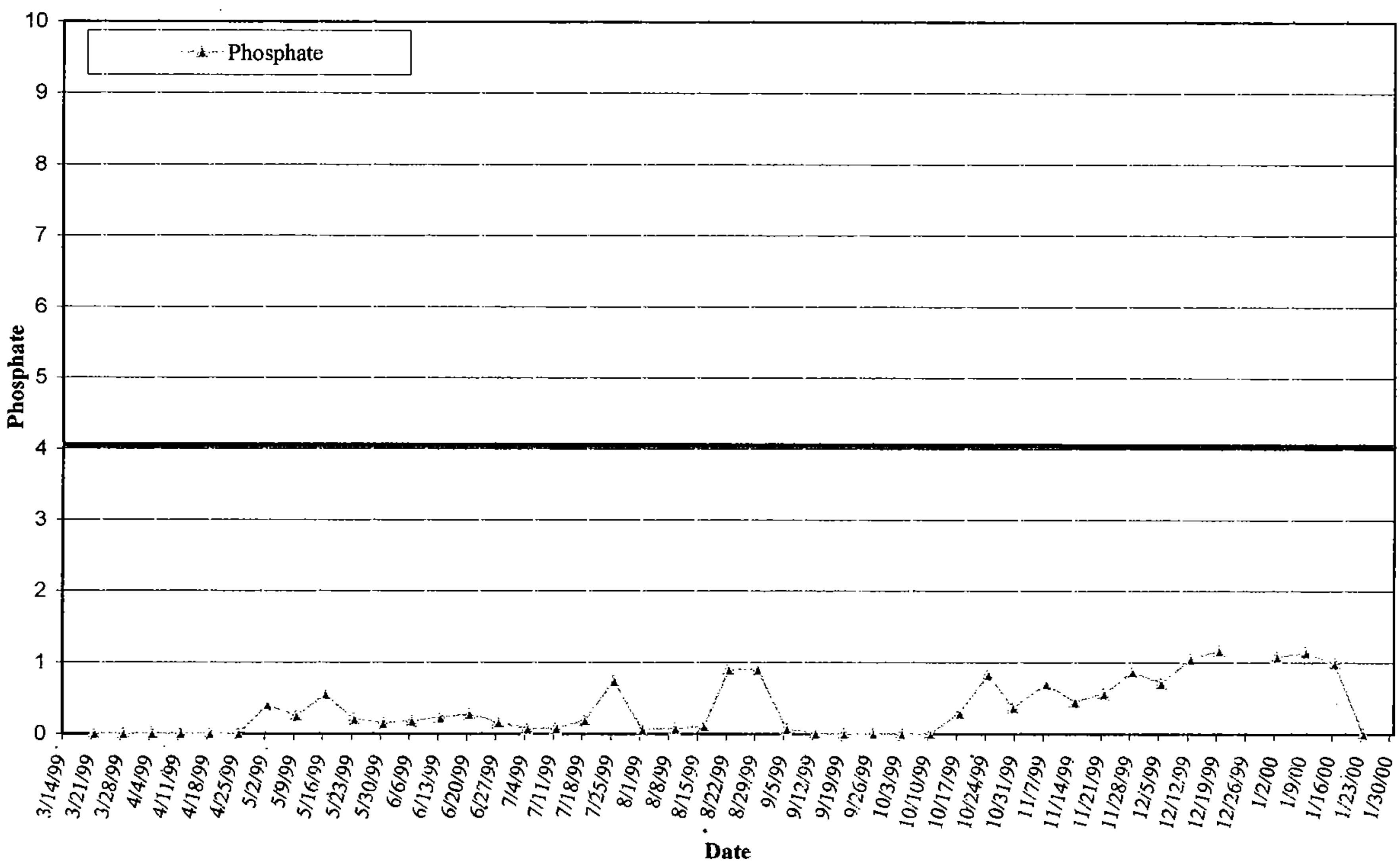
J. Phosphate at Doggett Brook



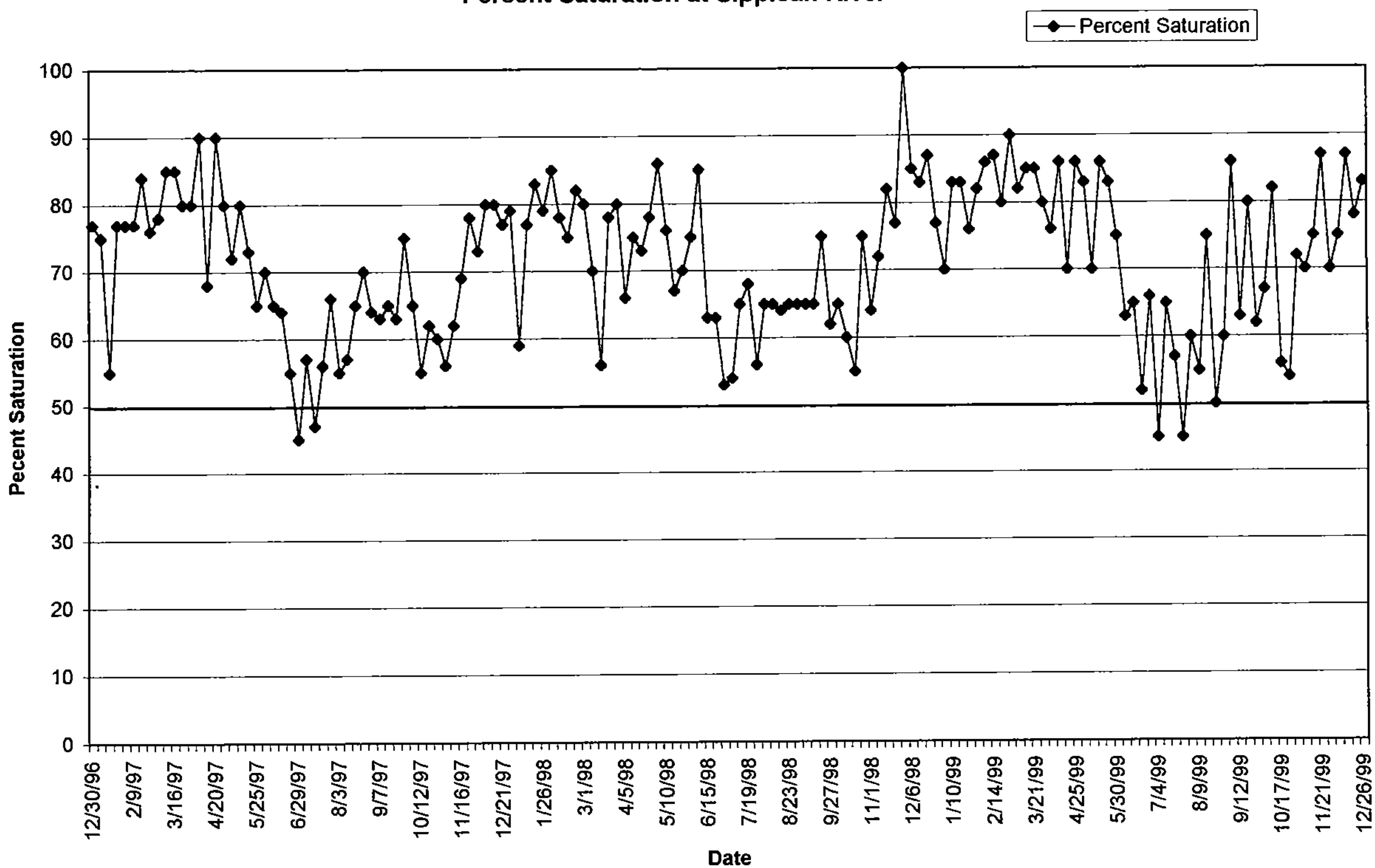
K. Phosphate at Sippican River

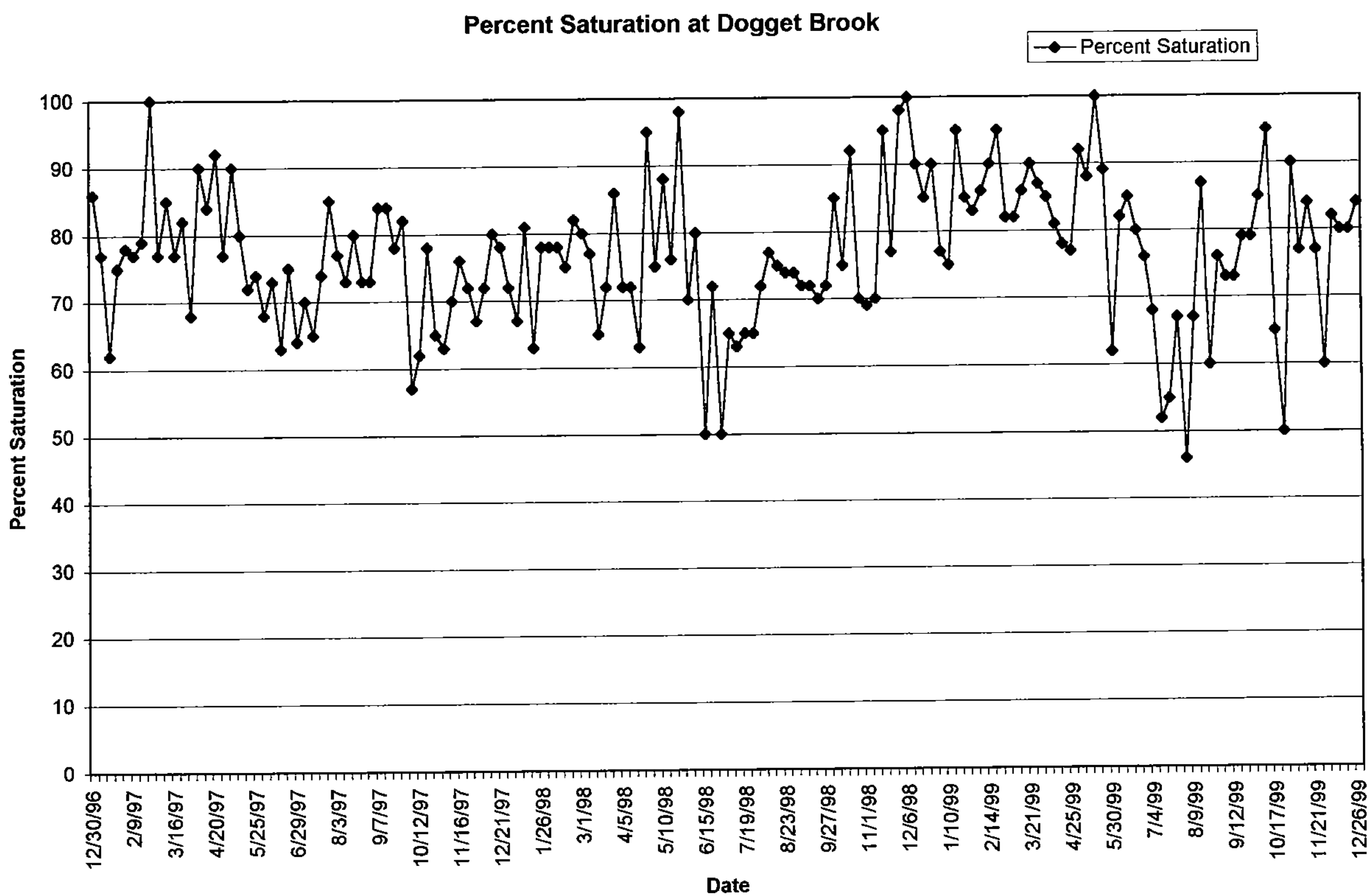


L. Phosphate at Hathaway Pond

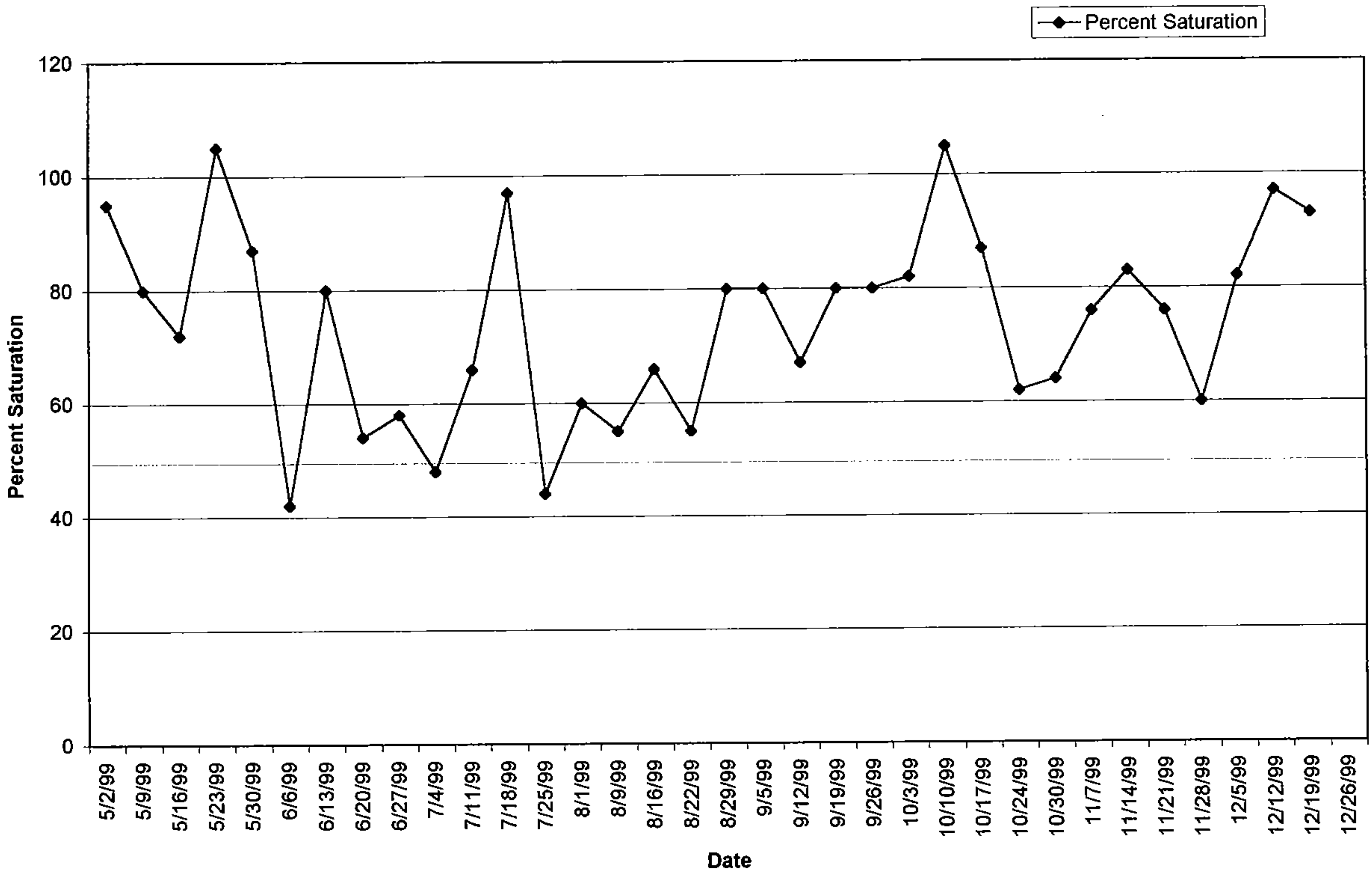


Percent Saturation at Sippican River




Percent Saturation at Dogget Brook
Percent Saturation
100
90
80
70
60
50
40
30
20
10
0
Percent Saturation
12/30/96
2/9/97
3/16/97
4/20/97
5/25/97
6/29/97
8/3/97
9/7/97
10/12/97
11/16/97
12/21/97
1/26/98
3/1/98
4/5/98
5/10/98
6/15/98
7/19/98
8/23/98
9/27/98
11/1/98
12/6/98
1/10/99
2/14/99
3/21/99
4/25/99
5/30/99
7/4/99
8/9/99
9/12/99
10/17/99
11/21/99
12/26/99
Date

Percent Saturation at Hathaway Pond



The Results … on average

	D.O.	pH	Total Nitrogen	Total Phosphate	Alkalinity
Acceptable	>5 mg/L	8.5-5.5	0-5.3 mg/L	0-4.2 mg/L	>20 mg/L
Hathaway Pond	8.0 mg/L	6.5	0.02 mg/L	0.44 mg/L	**13.78 mg/L**
Doggett Brook	8.9 mg/L	5.9	0.19 mg/L	0.55 mg/L	**13.46 mg/L**
Sippican River	8.3 mg/L	6.0	0.12 mg/L	0.92 mg/L	**13.44 mg/L**

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DISCUSSION

- On average the Sippican River system has good test ranges, see page following graphs, except for Alkalinity. Alkalinity is a measure of the ability of a body of water to resist changes in pH when acids are added. Acid additions generally come in the form of rain or snow, although soil sources may also be important in some areas. Alkalinity is generated when water dissolves rocks such as calcite and limestone. The alkalinity of natural waters protects fish and other aquatic organisms from sudden changes in pH levels, which could be detrimental to the aquatic health of the river. According to graphs (**A-C**), alkalinity trends are consistently low. Other than acid rain and snow, we are unsure of other reasons why the Alkalinity is so low, therefore, the river needs further testing beyond our capacity at this time.

- Dissolved Oxygen, or DO, is the amount of oxygen gas dissolved in water. Dissolved Oxygen is essential for the maintenance of healthy lakes and rivers. The presence of oxygen in quantities greater than 5 mg/L in water is a positive sign. The absence of DO in water or levels below 5 mg/L is a signal of possible pollution. Most aquatic organisms rely on dissolved Oxygen for survival. Dissolved Oxygen also tends to be a problem at times. As shown in the graphs (**D-F**), over the three years, there has been a steady drop in Dissolved Oxygen at all three testing sites. Concern about this decline has been raised, because, a drop in Dissolved Oxygen can signify many things, including high nitrogen levels leading to Eutrophication. As well, these low levels harm aquatic life by leaving them with an inadequate supply of breathable oxygen.

- Total Nitrogen is the amount of Nitrate and Nitrite in the water. Nitrogen causes Eutrophication, which promotes plant growth and decay, thus leading to lower dissolved oxygen. Sources of Nitrates include sewage, septic systems, fertilizers and runoff from dairy, barnyards and feedlots. According to graphs (**G-I**), the readings are relatively low, leading us to believe that there is no Eutrophication due to Nitrate occurring in the Sippican River system. Safe levels of Nitrogen are between 0-5.3 mg per liter.

- The largest concern with the Sippican River watershed is phosphate. Phosphate leads to cultural Eutrophication and comes from several sources: mainly laundry detergents, human and animal wastes, industrial wastes, soil erosion, and human disturbance of the land and its vegetation. According to graphs (J-L), although it may seem that the phosphate levels are low and therefore good, there are several days where there were extremely high phosphate levels. On November 14, 1999, there was a phosphate spike at Sippican River where the phosphate level was measured over **4.12 mg/L**. The same day, a white bag was noticed in the river. The initial reaction was a fertilizer spill. When looking at the total Nitrogen, the other indicator of fertilizer, it showed that total nitrogen levels were too low to even consider fertilizer as the culprit. In January, there was a spike as high as **9.06 mg/L** in Sippican River. In Doggett Brook, there was a phosphate reading as high as **4.86 mg/L** three weeks after the initial observation. Fertilizer has been ruled out due to the low Nitrogen levels. However, there is a storm drain that empties into the river just upstream from where we take our measurements. The flow of water on the street from houses up the street flow directly to this storm drain. We believe that someone is using detergent (washing cars) or leaking detergent directly upstream (clothes, dishes, etc.) because detergent is the only possible phosphate carrier that does not affect the Total Nitrogen range.

CONCLUDING REMARKS

The GLOBE Program has given Tabor Academy the chance to measure the surface water of nearby freshwater systems. Environmental Science teacher, Richard Harlow, is concerned about the decline in the once rich Herring population of Sippican River. With our data taken over the past three years and our knowledge of the environment we have observed environmental changes that we feel are fairly significant.
Low Alkalinity, low Dissolved Oxygen levels during the summer and spikes of phosphate, suggest that the Sippican River is in a rather tenuous stage and needs to be monitored on a regular basis with local governmental support. Only with the support of the Selectmen and local residents with regular scientific aquatic measurements can the town hope to bring the herring fishery close to what it used to be.